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GEIKIE'S GEOLOGY¹

Geological Sketches at Home and Abroad. By Archibald Geikie, LL.D., F.R.S. With Illustrations. (London and New York: Macmillan and Co., 1882.)

Text-Book of Geology. By Archibald Geikie, LL.D., F.R.S. With Illustrations. (London: Macmillan and Co., 1882.)

II.

WE now come to consider the quality of the matter contained in the volume, the discrimination exercised in its selection, the validity of the theories presented, and the fidelity with which the science is portrayed. It is the function of a text-book to exhibit to the student an impartial and symmetric outline of the science. Its author is under obligation to present the views which are generally entertained by the great body of geologists, carefully withholding those which are peculiar to himself. From the great mass of available matter he must select that which will afford a well-balanced and comprehensive review, and he must sedulously avoid giving undue prominence to those matters which have special interest to himself by reason of his individual studies. In the work before us this has been accomplished in a manner which may truly excite admiration. Although the author is an original investigator in several departments of the science he delineates, he has permitted his own predilections to give little if any additional prominence to his special topics, and the wisdom he has displayed in the selection of material and the balancing of parts will commend itself to all professional readers.

It is useless to attempt an analysis of a work which is itself an epitome of a great science, but we may refer to the treatment of a few mooted points and to a few matters of novelty or of current interest.

The microscopical characters of rocks are treated more at length than in any other text-book. In the general account of rock characters they are accorded even more space than are the macroscopical, and they form part of the description of each specific rock. They are, moreover, illustrated by a series of cuts, showing the appearance of thin slices when highly magnified. A chapter is devoted to the subject of rock determination, and an analytical table is included therein.

The results of the *Challenger* exploration of the bottom of the ocean are given at some length, and the conclusion is drawn that the continental regions of the globe have been marked out from the earliest geological times. This is not treated as an hypothesis but as an established theory, and its logical consequences appear in numerous places.

In the taxonomic terms of stratigraphy, the convention of the Bologna Congress is not adopted. The terms *system*, *series*, and *stage* are used in the same order, but *group*, which by the congress was made more comprehensive than *system*, is by Geikie used as the equivalent of *stage*. He remarks, with propriety, that the attempt to alter the signification of a term so universally employed in English literature would produce far more confusion

than can possibly arise from a failure to conform to continental usage.

One of the most conspicuous omissions of the book is with reference to the antiquity of man. The subject is treated with great brevity, because it is regarded as belonging more properly to archæology, but an account is nevertheless given of the earliest human vestiges. Mention is made of man's association with the Loess and with the inter-Glacial deposits of Europe, but the Californian claims to his pre-Glacial existence are ignored. It is true that these claims have been disputed, and it is true that the evidence in regard to each of the individual finds upon which they rest is incomplete; but since Whitney has assembled all the facts in his "Auriferous Gravels," it must be admitted that their cumulative force entitles them at least to recognition and consideration, however slow we may be to accept them as demonstrative.

In the section which treats of man as a geological agent, there are enumerated a great variety of ways in which he modifies the face of nature, but one of the principal, if not indeed the chief of all, is omitted, namely, the stimulus he gives to denudation by tilling the soil. The mat of vegetation, living and decaying, which naturally covers the soil in all humid regions, affords great protection against the erosive work of rain. Not only is the beating of the rain resisted, but the velocity of its outflow is retarded, so that from surfaces of gentle inclination it washes away very few particles. When this mat has been removed, and especially when the surface has been stirred by the plough, the conditions become exceedingly favourable to rain erosion, and the rain rills are charged with sediment. Moreover, cultivation and the cutting of forests increase the magnitude of river floods, and since rivers perform their chief work of erosion and transportation during flood-stage, the quantity of their work is thus augmented. It is safe to say that the rate of degradation of the surface by rains and rivers is increased several hundred per cent. by the removal of forests and the tillage of the soil, and it may be added that for this reason most attempts to measure the natural rate of denudation by means of the outscour of rivers have been abortive.

The unconformability between the Archæan and the Palæozoic is not mentioned in such way as to convey an impression of the profoundness of the chronological break. There is no known locality where a newer formation rests conformably upon the Archæan. There are few where the discordance of dip is not great. There are few where the superior formation is not relatively unaltered, and none where the inferior formation is not highly metamorphosed. So far as we know, the Archæan strata were both thrown in great folds and plicated in detail, were universally subjected to a metamorphism such as in later rocks seems to have been accomplished only at a depth beneath the surface, and were subsequently worn away upon a most stupendous scale before they received any sedimentary covering within the regions now accessible for examination. Compared with this, all other chronological breaks are trivial, and we may almost say that, compared with this, all other stratigraphical breaks are local.

In treating of the condition of the interior of the earth, Geikie concisely presents the prominent hypotheses, and

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¹ Continued from p. 239.

then remarks that it is "highly probable that the substance of the earth's interior is at the melting-point proper for the pressure at each depth." In treating of the age of the earth, he sets forth the geological and the physical arguments with commendable brevity, but withholds all expression of individual opinion. In treating of the origin of orographical displacement he gives a brief history of opinion, and states that the contractional hypothesis is now generally accepted. A foot-note, however, refers to Fisher's "Physics of the Earth's Crust," which appeared while the text-book was passing through the press. The cause of ice motion is not discussed.

In the classification of formations there is nothing new. The Cambrian and Silurian are marked as independent and co-ordinate divisions, the latter beginning with the Arenig group in Great Britain and with the Calciferous in America, but the opinion is expressed that a subsequent revision of the subject may result in "throwing all these older Palæozoic rocks into one palæontological system." The pre-Cambrian rocks are designated by Dana's title of Archæan. The Rhætic is included with the Trias. In the table of formations the American Laramie is placed in the Tertiary; but this appears to have been done by inadvertence, for in the descriptive text which follows it is treated as Cretaceous.

In the classification of rocks the primary division is into crystalline and clastic. The crystalline are separated into stratified, foliated, and massive, and the clastic into sand rocks, clay rocks, volcanic fragmental, and organic fragmental. Of the massive crystalline rocks, the principal sub-group is indicated as *feldspar bearing*, and four small groups (the nepheline rocks, the leucite rocks, the olivine rocks, and the serpentine rocks) are indicated as co-ordinate with this.

The subject of geological climate is treated almost exclusively from the astronomical point of view, and the theory of Croll is the only one which receives more than passing mention. Its statement was prepared especially for the volume by Dr. Croll himself, and covers six pages. It is undoubtedly true that this theory has been widely accepted, that it is very generally entertained as a working hypothesis, and that it is the most probable one before the public; and it should for these reasons be given great prominence in a text-book; but I cannot help regretting that it has been presented with so little qualification. It deals with a series of physical laws and physical conditions which interact upon each other in an exceedingly complex way—in so complex a way that meteorologists, who have to deal with only a portion of them, do not claim and scarcely hope for a complete analysis of their combinations. The opportunities for arguing in a circle are most seductive, and the *a priori* probability that important considerations have been overlooked is not small. The only manner in which so comprehensive and intricate an hypothesis can be established is by stimulating inquiry which shall lead to corroborative evidence, and this is precisely what Croll's hypothesis after eight years of wide publicity has failed to do. If it is true, then epochs of cold must have occurred with considerable frequency through the entire period represented by the stratified rocks; and iceberg drift, if no other traces, should have been entombed at numerous horizons. It has not been found, however, and of the eight horizons claimed by

Croll to show evidence of glacial action, the treatise under consideration mentions only two with confidence, and two others with doubt. In the two instances to which queries are not attached, the phenomena appear to indicate local and not general glaciation. If the hypothesis is true, the cold of the Glacial epoch must have been many times interrupted by intervals of exceptional warm, but little has been added to the evidence adduced by Croll for such an interruption, and in America, where there is now great activity in the investigation of glacial phenomena, the evidence of a *single* inter-glacial period is cumulative and overwhelming, while there is no indication whatever of more than one. If the hypothesis is true, submergence in polar and temperate regions should have been coincident with glacial expansion, and emergence coincident with glacial retreat, but the Quaternary history of Great Britain, as drawn in the new text-book, includes two periods of maximum ice-extension, *separated* by a period of maximum submergence. While these difficulties exist it appears to me unadvisable to convey to the student the impression that a satisfactory solution to the problem of glacial climate has been reached.

Because I have mentioned some points in which my individual judgment differs from that of Prof. Geikie, it must not be supposed for a moment that I undervalue his work, or that I regard it with anything short of enthusiastic commendation. It is broad and catholic, conscientious in detail, masterly in treatment. It is imbued especially with a spirit which for want of a better name may be called scientific modesty. The majority of our text-books, including all of our best text-books, have been written by teachers, and have been more or less affected by the peculiar mental attitude of the teacher. The investigator is under the constant necessity of holding his judgment in abeyance, and of treating every conclusion as an hypothesis, to be tested by future researches, and possibly amended or even abandoned. The teacher is under an equal necessity to formulate his knowledge so that he may communicate it in definite shape—he must not doubt, he must know; and under this compulsion he naturally and unconsciously acquires an undue confidence in results that have simply arisen from the weighing of probabilities. He is especially tempted to regard classifications as final, and not to recognise them as temporary presentations of temporary stages of knowledge. It is the especial merit of Prof. Geikie's book that it is untainted by this teacher's bias. It cautions the student against the confusion of geological synchrony with stratigraphical homotaxis; it cautions against the free use of palæontological evidence in the inference of geological climate; it cautions against deductions which may be vitiated by the imperfection of the geological record, and against negative evidence in general; it cautions against the impression that there are in nature any hard and fast lines separating epochs or formations or rock species; and, in addition, it heeds its own cautions. Its readers cannot escape the impression that the science of geology is in its youth, that it is developing at a rapid rate, that many of its results are tentative, and that its unsolved problems are as numerous and important as those it has successfully attacked.

It is only by a conscious effort that one gives attention to the literary style of Prof. Geikie's text-book. It is so

direct and plain that it serves the purpose of conveying thought without leaving an impression of the manner of conveyance. As in the matter, so in the manner, his personality is not permitted to intrude. He says one thing at a time, and therefore his sentences are short; but he does not exaggerate, and therefore he never indulges in epigram.

A noteworthy feature of the illustrations is the reproduction of a large number of De la Beche's cuts, which are derived directly from the original blocks. All of these are good, and so are the majority of the remaining illustrations, but there is also a considerable number, especially in the chapters on stratigraphy, which are not so distinct as is desirable, and which probably owe their imperfection to the employment of some photo-mechanical process. The typography is excellent, and a page of errata is not called for.

The foot-notes contain a very large number of useful references. These are not mere citations of authorities in support of statements in the text, but are indications to the student of treatises in which he may find the fullest exposition of subjects to which the text introduces him.

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SACHS'S TEXT-BOOK OF BOTANY

Text-Book of Botany, Morphological and Physiological.

By Julius Sachs, Professor of Botany in the University of Würzburg. Edited, with an Appendix, by Sidney H. Vines, M.A., D.Sc., F.L.S., Fellow and Lecturer of Christ's College, Cambridge. Second Edition. (Oxford, 1882.)

THERE are not wanting signs that the study of botany is steadily increasing in this country. An immense number of text-books or manuals have been published in English during the last thirty years on the subject, some of which have been very popular, to judge by the many editions they have passed through. Referring to these introductions to the study of botany in general terms, it was to be noted that they all, in a more or less complete manner treated of the vegetable kingdom from a morphological and classificatory point of view; but that the morphological portions were deficient in clear descriptions or conceptions of the origin or development of the members of the plant's body which they described, and the student who required instruction as to physiological, anatomical, or embryological details, had to look for such in the pages of the botanical periodical literature of the day. Most modern workers in biology will agree that the greater portion of this literature was derived from German sources, and it is scarcely to be denied that the first general compendium of note appeared in the German text-book of Sachs. This work had reached a fourth edition in 1874, but the previous editions had found their way into several of the centres of botanical teaching in Great Britain and Ireland, and had caused a considerable change in the older methods of teaching botany. Still it must have been a matter requiring some courage for the delegates of the Clarendon Press to undertake the costly work of translating, editing, and printing in English this work of Sachs', forming a large octavo

volume of nearly 1000 pages, a text-book one would think far too large and expensive for most ordinary students. This work was, however, issued from the Clarendon Press in the spring of 1875, and it is not without interest to note that for the last two or three years it has been completely out of print, so that the edition must have been exhausted in the course of the first four or five years after its issue. It was most unfortunate that this edition, so ably translated by Messrs. Bennett and Thiselton Dyer, had not been based on the fourth German edition, which had been published nearly a year before the English translation made its appearance. The success of the translation may, however, be looked on as to a certain extent condoning this misfortune, and there can be doubt as to the revolution in the study of botany in these kingdoms, which has been brought about by its appearance. Instead of to an endless catalogue of under- and above-ground forms of stems, instead of a list as long as that of the ships in Homer of the forms of simple and compound leaves, the student has had his attention—at least in some schools—called to the important structures to be met with in these varied portions of a plant and to their peculiar functions and ontogeny. The subject of plant life and development seems to have become of more especial interest and to have fallen like a new story on many even old ears. It was not, under these circumstances, surprising that a new edition was called for, but it did excite some surprise that, having in a great measure made the demand, the Delegates of the Clarendon Press seemed unable for a time to supply it, and let several Long Vacations glide by without its appearance; even this new edition comes to us late in the autumn season of the year, when the year's fruits have been well garnered in. Still it is welcome as an important contribution to the study of a science that has of old and for long been fostered by the University of Oxford.

Welcome as this new edition is, it would, we firmly believe have been a much more complete text-book and have reflected more of credit on the Clarendon Press Series, if the present Editor had been given a fairer field to work on. Although the fourth German edition was in advance of the previous one, yet the half-dozen years that have elapsed since it made its appearance have been years during which botany has advanced with no tardy footsteps. Even Prof. Sachs himself could not be persuaded to face the torture of a fifth edition of the original, for he felt, as he tells us, that the expanded views of the present period would not even fit into the framework of his text-book, so that a faithful translation of the fourth edition is even more out of date in 1882 than the translation of the third edition was in 1875.

Hence it must have been distressing for the Editor of the volume before us to find, on entering on his task, that nearly the whole of Book I., which treats of the general morphology of the cell, the tissues, and the external conformation of plants had been for some time in type, and that consequently a number of recent discoveries had not been noticed in it. No one could have been better fitted than Mr. Vines to have brought this most important section up to date, and it is a pity that only 32 out of its 232 pages were reprinted, for there is a decided awkwardness in looking in an appendix for supplementary